

E30-053CON (00-142CON)

What is claimed as new and desired to be secured by
Letters Patent of the United States is:

1. A method for facilitating a data recovery that copies data to a first data store from a second data store that is operable in a first mode as a mirror to the first data store and that is operable in a second mode in isolation from the first data store, said data recovery operation comprising the steps of:

- A) disabling the transfer of data to locations in the second data store,
- B) identifying the locations in the first data store to receive data from the second data store in response to the command,
- C) performing a restoration procedure that copies data to the identified locations in the first data store from corresponding identified locations in the second data store,
- D) performing an updating procedure that updates data on the first data store based upon changes to data in the first data store recorded after the second data store shifts to its second operating mode, and
- E) enabling the transfer of data to locations in the second data store upon completion of the restoration and updating procedures whereby the data in the second data store remains unchanged throughout the data recovery operation.

2. A method as recited in claim 1 additionally comprising the step of identifying the locations in the first data store that are altered during the updating procedure.
3. A method as recited in claim 2 wherein said restoration procedure comprises a copy process that copies data from the second data store to the first data store and the updating procedure comprises a writing process that writes
5 data to the first data store, said method additionally monitoring the operation of the copying and writing processes to enable the restoration and updating processes to operate concurrently.
4. A method as recited in claim 3 wherein each of the data stores maintains status information for monitoring the validity of the data in the storage locations of the first and second data stores and wherein said copy process
5 transfers data to a storage location in the first data store prior to a write operation whereby the status information for the first and second data stores indicate that the data in those locations are invalid and valid, respectively.
5. A method as recited in claim 4 wherein the updating procedure writes an entire storage location in the first

data store and wherein the writing process causes the status information to indicate that the data in the first and second data stores are valid and invalid, respectively.

6. A method as recited in claim 4 wherein the updating procedure writes a portion of a storage location in the first data store, said writing process causing the status information to indicate that the data in the storage locations in the first and second data stores are invalid and valid, respectively, whereby said copy process initiates a transfer of the combined written data and data from the second data store to the storage location in the first data store.
7. A method as recited in claim 3 wherein each of the data stores has associated status information for monitoring the validity of the data in the storage locations of the first and second data stores and wherein the updating procedure transfers written data to a storage location in the first data store prior to the restoration procedure, the transfer of data to a location in the first data store by the writing process being dependent upon an indication in the status information of valid data in the first data store location.

8. A method as recited in claim 3 wherein each of the data stores has associated status information for monitoring the validity of the data in the storage locations of the first and second data stores and wherein the updating procedure transfers written data to a portion of a storage location in the first data store prior to the restoration procedure, the writing process leaving the status information unchanged whereby subsequently the copy process initiates a transfer of the combined data in the corresponding location of the second data store and the written data to the location in the first data store.
9. A method as recited in claim 8 wherein said copy process additionally causes the status information for the storage locations in first and second data to store invalid and valid states, respectively.
10. A method as recited in claim 1 wherein said identification of data to be transferred by the restoration procedure includes an identification of all the data in the second data store.
11. A method as recited in claim 1 wherein the first and second data stores are further characterized by a second

identification of data that reflects changes in the first data store after the second data store transfers to the second operating mode, said first identification of data to be transferred by the restoration procedure being set to correspond to the second identification.

12. A data recovery program that restores data in a first storage device with data from a second storage device and updates the first storage device with data supplied from a host wherein each storage device comprises a plurality of tracks on a physical disk and communicates with a storage buffer, wherein the second storage device operates either in a first, write-enabled, mode for mirroring the first storage device or in a second mode isolated from the first storage device and wherein a track identification table for each of the first and second storage devices defines the status of the data in each track of the first and second storage devices, said data recovery program:

- A) attaching the second storage device in a write-disabled state to the first storage device,
- B) identifying tracks to be restored from the second storage device to the first storage device, and
- C) initiating concurrent restoration and updating of the data by:

- 20 i) copying the data from the identified tracks in
 the second data storage device to the storage
 buffer in response to the information in the
 first track identification table,
- ii) transferring update data received from the host
 to the buffer storage device, and
- 25 iii) responding to a predetermined track status for a
 first storage device track by transferring
 corresponding data from the storage buffer to
 the first storage device.

13. A data recovery program as recited in claim 12
 additionally identifying the locations in the first data
 store that are altered during the updating procedure.
14. A data recovery program as recited in claim 13 wherein
 each said update transfer comprises a writing process that
 writes data to the first data store and wherein said
 program additionally comprises monitoring the operation of
5 the copying and writing processes to enable the
 restoration and update transfers.
15. A data recovery program as recited in claim 14 wherein
 each of the data stores maintains status information for
 monitoring the validity of the data in the storage

5 locations of the first and second data stores and wherein
said data copying transfers data to a storage location in
the first data store prior to a write operation whereby
the status information for the first and second data
stores indicate that the data in those locations are
invalid and valid, respectively.

16. A data recovery program as recited in claim 15 wherein
each update transfer writes an entire storage location in
the first data store and wherein the writing process
causes the status information to indicate that the data in
5 the first and second data stores are valid and invalid,
respectively.

17. A data recovery program as recited in claim 15 wherein an
update transfer writes a portion of a storage location in
the first data store, said writing process causing the
status information to indicate that the data in the
5 storage locations in the first and second data stores are
invalid and valid, respectively, whereby said copy process
initiates a transfer of the combined written data and data
from the second data store to the storage location in the
first data store.

18. A data recovery program as recited in claim 14 wherein each of the data stores has associated status information for monitoring the validity of the data in the storage locations of the first and second data stores and wherein an update transfer writes data to a storage location in the first data store prior to the restoration procedure, the transfer of data to a location in the first data store by the writing process being dependent upon an indication in the status information of valid data in the first data store location.

19. A data recovery program as recited in claim 14 wherein each of the data stores has associated status information for monitoring the validity of the data in the storage locations of the first and second data stores and wherein an update data transfer writes data to a portion of a storage location in the first data store prior to the restoration procedure, the writing process leaving the status information unchanged whereby subsequently the copy process initiates a transfer of the combined data in the corresponding location of the second data store and the written data to the location in the first data store.

20. A data recovery program as recited in claim 19 wherein said data copying additionally causes the status

information for the storage locations in first and second data to store invalid and valid states, respectively.

21. A data recovery program as recited in claim 12 wherein said copying of data by the restoration procedure includes an identification of all the data in the second data store.
22. A data recovery program as recited in claim 12 wherein the first and second data stores are further characterized by a second identification of data that reflects changes in the first data store after the second data store transfers to the second operating mode, said first identification of data to be transferred by the restoration procedure being set to correspond to the second identification.
23. Data recovery apparatus for facilitating a data recovery that copies data to a first data store from a second data store that is operable in a first mode as a mirror to the first data store and that is operable in a second mode in isolation from the first data store, said data recovery apparatus comprising:
 - A) means for disabling the transfer of data to locations in the second data store;

- 10 B) identification means for identifying the locations in
the first data store to receive data from the second
data store in response to the command,
- 15 C) restoration means for performing a restoration
procedure that copies data to the identified
locations in the first data store from corresponding
identified locations in the second data store,
- 20 D) updating procedure means for performing an updating
procedure that updates data on the first data store
based upon changes to data in the first data store
recorded after the second data store shifts to its
second operating mode, and
- 25 E) means for enabling the transfer of data to locations
in the second data store upon completion of the
restoration and updating procedures whereby the data
in the second data store remains unchanged throughout
the data recovery operation.

24. Apparatus as recited in claim 23 additionally comprising
means for identifying the locations in the first data
store that are altered by said the updating procedure
means.

25. Apparatus as recited in claim 24 wherein said restoration
means comprises copy means for copying data from the

second data store to the first data store and said
updating procedure means comprises means for writing data
5 to the first data store, said apparatus additionally
comprising means for monitoring the operation of said
copying and writing means to enable said restoration and
updating procedure means to operate concurrently.

26. Apparatus as recited in claim 25 wherein each of the data
stores maintains status information for monitoring the
validity of the data in the storage locations of the first
and second data stores and wherein said copying means
5 transfers data to a storage location in the first data
store prior to a write operation whereby the status
information for the first and second data stores indicate
that the data in those locations are invalid and valid,
respectively.

27. Apparatus as recited in claim 25 wherein the updating
procedure means writes an entire storage location in the
first data store and wherein said writing means causes the
status information to indicate that the data in the first
5 and second data stores are valid and invalid,
respectively.

28. Apparatus as recited in claim 26 wherein said updating procedure means writes a portion of a storage location in the first data store, said writing means causing the status information to indicate that the data in the storage locations in the first and second data stores are invalid and valid, respectively, whereby said copying means initiates a transfer of the combined written data and data from the second data store to the storage location in the first data store.
29. Apparatus as recited in claim 25 wherein each of the data stores has associated status means for monitoring the validity of the data in the storage locations of the first and second data stores and wherein the updating procedure means writes data to a storage location in the first data store prior to said restoration means, the transfer of data to a location in the first data store by said writing process being dependent upon an indication in the status means of valid data in the first data store location.
30. Apparatus as recited in claim 25 wherein each of the data stores has associated status means for monitoring the validity of the data in the storage locations of the first and second data stores and wherein the updating procedure means writes data to a portion of a storage location in

the first data store prior to said restoration means, said writing means leaving said status means unchanged whereby subsequently said copy means initiates a transfer of the combined data in the corresponding location of the second data store and the written data to the location in the first data store.

- 10
31. Apparatus as recited in claim 30 wherein said copy means additionally causes said status means for the storage locations in first and second data to store invalid and valid states, respectively.
32. Apparatus as recited in claim 23 wherein said identification means includes an identification of all the data in the second data store to be copied by said restoration means.
33. Apparatus as recited in claim 23 wherein the first and second data stores are further characterized by a second identification of data that reflects changes in the first data store after the second data store transfers to the second operating mode, said identification means for data to be transferred by said restoration means being set to correspond to the second identification.
- 5